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Digital sustainability and its implications for finance and climate change

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Special Feature A

Digital Sustainability and its Implications for Finance and Climate Change

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As the pandemic forced the entire world to a virtual standstill, nature revived a little. The US emitted 10.3% less CO_2 in 2020 than in 2019 and other regions similarly experienced emission declines. Depending on the source, global carbon emissions were down between 4 and 8% in 2020.[2] Consumers globally have expressed more concern about sustainability, an observation confirmed by large survey research by Accenture, Kantar, Boston Consulting Group (BCG), and Ipsos.[3] In its latest Emissions Gap Report[4], the UN Environment Programme (UNEP) explicitly connected the pandemic to climate change, nature loss, and pollution. Besides the acceleration of business digitalisation with the move to work-from-home, the pandemic has created a shift in how we think and talk about sustainability. Our thesis is that digitalisation and sustainability are converging and that new digital technologies will empower novel sustainability solutions that may help avoid the worst of climate change.

1 Digitalisation and Sustainability are Converging

Two seemingly disparate trends have dominated in the latest decade. On the one hand, digital transformation has become a key aspect of every business. With mobile internet penetration, information availability has created a better-informed civil society. Cloud computing has eased scalability constraints by eliminating complexity and by linearising the costs of scaling digital infrastructure. Novel technologies such as blockchain, artificial intelligence and machine learning (AI/ML), the internet of things (IOT), big data, and 5G are becoming pervasive in business.

After a few boom-and-bust cycles, Bitcoin and other cryptocurrencies are near all-time highs, attracting investment from former sceptics. Notably, the emerging decentralised finance (DeFi) revolution is promising to make business transactions fairer, and more open, efficient, and reliable. AI/ML is bringing new capabilities to domains as diverse as education,

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[2] Kottasova, I (2021), "US Carbon Emissions Fell 10% in 2020, Because of the Pandemic. It's Up to Biden to Stop Them from Bouncing Back", *CNN*, January 12.

[3] These surveys can be found at the following URLs: https://www.accenture.com/_acnmedia/PDF-134/Accenture-COVID-19-Pulse-Survey-Wave7.pdf%20-%20zoom=40 (Accenture); https://kantar.turtl.co/story/whocares-who-does-2020-p/page/6 (Kantar); https://www.bcg.com/publications/2020/sustainability-matters-now-more-than-ever-for-consumer-companies (BCG); and https://www.ipsos.com/ipsos-mori/en-uk/two-thirds-britons-believe-climate-change-serious-coronavirus-and-majority-want-climate-prioritised (Ipsos).

[4] The report can be found at the following URL: https://www.unep.org/interactive/emissions-gap-report/2020/.

pharmaceuticals, security, and agriculture, which could add 14% to global GDP by 2030 (PwC, 2017). Powered by 5G, the IOT will connect billions of devices, making everything in our homes, our offices, and our factories 'smarter' while feeding a massive increase in data availability. Eventually, society and the economy may function as a network of smart houses, smart transportation, smart electricity grids, and smart cities that increase economic exchange by lowering transaction costs.

On the other hand, sustainability, especially Sustainable Development Goal 13 (climate action), has become recognised as an existential challenge for humanity. The Canadian, EU, and UK parliaments have declared a climate emergency while many countries, including China and Singapore, have sharpened their sustainability targets with long-term plans. Implementing these plans could bring a new kind of prosperity. Scientists posit that increasing the quantum of nature reserves in the world from its current 10.7% to 30% of the world's surface would be a gamechanger for climate change and biodiversity, while at the same time increasing economic growth and human well-being (Waldron *et al.*, 2020). Yet, well-respected publications on climate change (IPCC, 2018) and biodiversity (Díaz *et al.*, 2019) still paint a dire picture of the future and call for bolder action.

In practice, we see an increasing number of companies engaging in sustainability reporting. Leading multinationals are setting ambitious environmental goals in the form of science-based targets and initiating restorative goals to become net-positive contributors to a healthier planet (Delmas *et al.*, 2019; Schillebeeckx, 2021). Management scholars have also articulated the need to investigate the consequences of, and organisational triggers behind, climate change, inclusive growth, natural resource management, and societal resilience (George *et al.*, 2015; Howard-Grenville *et al.*, 2014). From these trends, we can infer an opportunity for transformational change.

We submit that the digitalisation and sustainability trends are converging and could power this opportunity. In earlier work, we defined digital sustainability as *the organisational activities that seek to advance the sustainable development goals through creative deployment of technologies that create, use, transmit, or source electronic data* (George *et al.*, 2020). The concern for climate change is met with the optimism of mission-driven organisations that believe that the creative deployment of digital technologies will address some of the most intractable problems of our time.

2 The Drivers of Digital Sustainability

Three forces that have increased the use of digital technologies to address sustainability challenges underpin our convergence hypothesis: (1) expansion of corporate purpose, (2) economies of collective action, and (3) appropriability of private value from creating public goods.

Increasingly, **companies define their purpose in broader terms**. In a forthcoming paper, we state, "purpose in the for-profit firm captures the essence of an organisation's existence by explaining what value it seeks to create for its stakeholders. In doing so, purpose provides a clear definition of the firm's intent, creates the ability for stakeholders to identify with, and be inspired by the firm's mission, vision, and values, and establishes actionable pathways and an aspirational outcome for the firm's actions" (George *et al.*, 2022). Industry experts extol the virtues of purpose and link it to enhanced performance because it underpins employee engagement, hiring, motivation, innovation, consumer loyalty, and financial performance. Firms have started to define such purpose with explicit social and environmental goals that

are core to their identities and fall within their scope of influence. It is therefore no surprise that companies have started deploying technological tools, including those of digitalisation, to address the biggest challenge of the century. Similarly, we have seen companies rapidly digitise their offerings and services during the pandemic to survive, and even thrive, during extended periods of lockdown or circuit breakers. Companies are using the digitalisation toolbox including blockchain, AI/ML, IOT, 5G and mobile to tackle climate change.

Digitalisation has also empowered smaller companies. Much like how cloud computing collectivised the economies of scale wherein small businesses could benefit from similar economies of scale as larger entities, digitalisation has more generally created **economies of collective action**. Through digital technologies, companies and individuals find it easier to coordinate and to transact with one another, either through information layers on the internet or through exchange layers that are intermediated by third parties or blockchain systems. This has enabled a wider participation towards addressing critical environmental challenges. Interestingly, consumers seem to intuitively know this, as 95% of respondents to a BCG survey believe their personal actions could help reduce waste, tackle climate change, and protect biodiversity and this belief has strengthened during the pandemic (Kachaner *et al.*, 2020).

In essence, digitalisation has enhanced our capacity to coordinate in non-hierarchical systems, which, in combination with growing awareness, has empowered agents all over the world to act. Digitalisation has increased knowledge access and sharing (e.g., information storage, open source), decentralised knowledge creation (e.g., Wikipedia, distributed computing), freed knowledge exchange (e.g., from mail and messaging to Clubhouse), and is decentralising value exchange (via blockchain). All these irreversible trends lead to more decentralisation of power, which, in turn, gives people and businesses the tools to create meaningful change that aligns with their higher-level purpose.

A growing sense of purpose attracts companies to take climate action using the tools at their disposal, while digitalisation is widening the portfolio and the exposure of relevant stakeholders. Together, they provide a powerful engine for change. Within a capitalist system however, they still lack a crucial element—value appropriation. Here again, digitalisation is enabling organisations to **appropriate private value from the creation of public goods** in completely new ways. Digitalisation has enabled us to map large parts of the natural world, and our ability to monitor that natural world's evolution is not only important to ensuring that we preserve it or pay attention to it (as David Attenborough has done throughout his career) but is also increasingly a currency that creates private value. As companies and nations commit to carbon neutrality, carbon stored in forests and oceans is quantified, and that information is being monetised. Thus, what digitalisation has enabled is the appropriation of private value from the creation of public goods in a way that was virtually impossible a decade ago. These three trends together underpin the digital sustainability convergence hypothesis, and they give rise to a variety of new opportunities.

3 Opportunities in Digital Sustainability

Digital technology is enabling us to solve problems in novel ways. Our previous work introduced a variety of digital tools that businesses are using to address sustainability challenges (George *et al.*, 2020). We revisit these tools and highlight innovative businesses that are using them to create solutions. A short overview is provided in **Table 1**.

Table 1 The digital toolbox and its proponents

Tool	Technology	Illustrative Exemplars
Instrumentation	Remote sensing, AI/ML, IOT	Kumi Analytics, Intensel
Tokenisation	Blockchain, Airtable	Air Carbon, Carbon Ethics, Seven Clean Seas
Gamification	Mobile, GPS	Ant Forest, Atlas Go
Re-intermediation	Digital platforms, mobile, apps, integration	Handprint, Olam
Contracting and layering	Blockchain	DiMuto
Digitising institutions	All the above	Georgia, Ukraine

Instrumentation captures activities involved in creating digital instruments and insights for decision-making on climate change and its effects. These activities include the simple tracking of energy usage and waste generation to enhance factory efficiencies and the deployment of IOT devices to track real-time events such as leaks and spikes in energy consumption, as well as more advanced ways of codifying observations of the natural world to inform trading, as well as risk and resilience assessments and to monitor environmental state change. In Singapore, Kumi Analytics uses satellite data and advanced machine learning to predict crop volumes and estimate carbon sequestration in mangrove forests, both of which can inform trades in underlying assets. Intensel, a winner at the Singapore Fintech awards in 2020, uses similar technologies to assess climate risks and helps companies visualise their exposure to specific climate risk.

Tokenisation is the transformation of assets to tradeable tokens that live on a blockchain architecture, or to non-fungible digital assets to which a third party can lay claim. Air Carbon is a carbon exchange that tokenises existing and certified carbon credits to enhance price transparency and liquidity and to support commodification of carbon projects. Carbon Ethics and Seven Clean Seas both use a simpler form of tokenisation and create respectively proof of planting of mangroves and coral reefs and proof of plastic clean-up in digital formats. Carbon Ethics tags each tree and coral, photographs them on a quarterly basis, and stores that information in a public Airtable. Such publication builds trust that impacts are real, not double-sold, and thus valuable to companies or individuals who want to lay claim to some of the public good benefits. Seven Clean Seas has government officials certify the daily haul of plastic and publishes its collection data to a password-protected database to which all its clients have access.

Gamification of existing services to benefit the planet emerged to cater to the growing demand from consumers to become involved in sustainable initiatives. Most notably, Ant Financial has designed the Ant Forest toolset within its Alipay payment application to encourage pro-environmental behaviours. Taking public transport, paying your bills online, and other services are rewarded with Energy Points that can be used to buy seeds to plant virtual trees. While gamified aspects have been built into the app (e.g., friends can steal energy points, you can water someone else's propagule), the real gamechanger is that Ant Financial transforms those virtual trees into real saxaul trees in a desert in Inner Mongolia

(Merrill *et al.*, 2019). Similarly, Atlas Go is a community application that companies can use to challenge their employees and other stakeholders to achieve a set goal. Companies can, for instance, run a health campaign and reward employees for walking 10,000 steps a day, and these rewards can be linked to public good creation such as donations to reforestation initiatives.

Re-intermediation occurs when innovative actors are disrupting existing transaction railroads in between different organisations to change how a supply chain or an ecosystem works. Olam is digitising the origination process for crops like coffee and cocoa by equipping small-scale farmers with mobile phones armed with a digital sales platform, which allows Olam to cut out price-setting intermediaries and to provide higher prices to farmers. Handprint is a platform company that creates an open market for positive impact projects (by doing active curation and digitalisation of non-governmental organisation (NGO) services) while also building digital toolsets for impact integration and automation. For instance, Handprint developed e-commerce plug-ins for WooCommerce and Shopify that empower merchants to communicate their commitment to the planet just before checkout. More generally, the underlying technology enables integration and automation of impact with any volume performance indicator that a company tracks digitally. While blockchain enables disintermediation and direct peer-to-peer engagement, we have not yet seen this more radical form in the digital sustainability space.

Contracting is the deployment of smart contracts on blockchain to automate certain elements of business logic between different parties while **layering** involves the addition of new types or more detailed information in business processes and transactions in order to create transparency. DiMuto is a trade technology company that champions collaborative commerce and has built blockchain-based solutions to facilitate international trade for fruits and vegetables by layering farm-to-fork supply chain visibility and trackable international trade documents onto existing international trade business processes to enhance transparency.

Finally, **digitising institutions** happens when businesses, governmental and NGOs use digital technologies to alleviate concerns caused by "institutional voids", which are typically associated with the absence of trust and the presence of corruption and other failures of markets, governments, norms, and institutions. Digital technologies can be used to address such issues in novel ways, by solving trust problems and in doing so, rebuild faith in institutions. In Georgia and Ukraine for instance, governments have, cognisant of their temporary nature and the risks of future authoritarianism and possible expropriation of property, turned to blockchain systems to create an undisputable authority of land ownership titles (Shang and Price, 2019; Verbyany, 2017).

4 The Green Finance Landscape

The convergence of sustainability and digitalisation is also altering the finance landscape. Private as well as public financial institutions are experimenting with the digital toolbox and are fast becoming crucial actors in the digital sustainability space. In 2017, MAS introduced a Sustainable Bond Grant Scheme to support the issuances of green, social and sustainability-linked bonds in Singapore, to channel capital towards catalysing broader adoption of sustainability practices. As part of Singapore's Green Plan, the government is now experimenting with green bonds, with S$19 billion worth of projects already identified (Mohan, 2021), and the potential for higher future issuance. While bonds are familiar financial products, green bonds are still in their infancy. The market for green bonds is growing rapidly,

although its size remains well below 1% of the US$128 trillion global bond market. To ensure that green bonds are indeed green, there is a need to monitor the environmental performance of underlying assets and report them in a cost-effective manner. This will increasingly rely on combinations of IOT, 5G, remote sensing (satellites and drones), and AI/ML.

DBS Bank has raised its sustainable finance targets from S$20 billion to S$50 billion by 2024, following a marked increase in demand, spearheaded by companies that have strengthened their commitments to environmental, social and governance (ESG) goals during the pandemic. The increase in ESG activity is promising and can be tied to a strategic reporting framework that ensures minimum levels of compliance while acknowledging material differences between, and even within, industries, such that companies are incentivised to report on key environmental and social impacts while being benchmarked against industry standards. To support research on these topics, the Singapore Exchange (SGX) can potentially create an open access, digital repository (a type of instrumentation) of annual reports and sustainability reports that are machine-readable and encourage listed firms to submit their reports in appropriate formats. This could unleash the power of ML to advance understanding of the Singapore economy and its companies' wider social and environmental impacts.

A Singapore consortium consisting of commodity broker Marex Spectron, Kumi Analytics and the Global Mangrove Trust (GMT) is working towards the issuance of "blue bonds". These are called blue because they finance coastal mangrove reforestation and conservation efforts in South East Asia, initially in Indonesia. The consortium is an example of financial innovation in the carbon space. Kumi Analytics is developing an automated system to verify and validate carbon sequestration in forests using remote sensing through satellites and machine learning. The estimated carbon that is being sequestered in growing or protected forests can be tokenised on GROVE, a blockchain application consisting of a series of smart contracts that has been developed by GMT with the help of the Disruptors, a group of elite developers working for DBS Bank and NUS blockchain spinoff Zilliqa. Together with Marex, the consortium partners are creating a digitally powered, ultra-scalable solution for carbon credits, specifically targeted at the commodity markets and primary industries.

Singapore Management University has, with the aid of MAS and in partnership with Imperial College London, set up the Singapore Green Finance Centre. The centre is dedicated to talent development and research in green finance, and supported by nine founding partners: Bank of China, BNP Paribas, Fullerton Fund Management, Goldman Sachs, HSBC, Schroders, Standard Chartered Bank, Sumitomo Mitsui Banking Corporation and UBS. The Centre's aim is to become a catalyst for embedding climate action into business strategy and to help Asia become a global leader in the transition to a low carbon future.

Another key trend, powered by blockchain, is DeFi. DeFi has the potential to disintermediate financial institutions through peer-to-peer distribution of financial products and services. While still in its infancy, DeFi has contributed to soaring valuations in the crypto markets and its implications for the financial sector can hardly be overstated. As blockchain enables the transfer of value without the need of a trusted intermediary (such as a bank), DeFi takes the next step and can create the benefits of centralisation (in terms of price discovery and market efficiency) without the need of central control. Examples include a stock exchange that is not run by a single organisation but exists as code on the Ethereum blockchain, a P2P lending or direct investment platform that exists only as a decentralised autonomous organisation, or a parametric insurance contract that automatically executes a payment if a certain parameter (e.g., rainfall in Sumatra exceeds 55 ml in March) is met. While these examples may currently seem fanciful or impractical, their first iterations already exist,

and if or when they scale, will have substantive consequences for regulation and the larger finance ecosystem.

5 Conclusion

The world has changed. Climate change is now a priority in every boardroom. The convergence of digitalisation and sustainability is providing new tools that enable and empower businesses and governments alike to make a lasting impact on the planet's natural capital. As businesses espouse greater social and environmental purpose, and digital technologies magnify economies of collective action and the appropriability of private value from public goods, opportunities abound to truly shape our planet into a better one.

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